Information

Drugs to Induce Hypotension

RICHARD J. SPERRY, MD
Salt Lake City

EARLY STUDIES OF HEMODYNAMICS during induced hypotension focused principally on global cardiovascular indices such as cardiac output and systemic vascular resistance, whereas regional blood flow and tissue oxygenation received little consideration. New laboratory techniques such as the radiolabeled microsphere and diffusable radioactive tracer methods for determining regional blood flow and microelectrodes for measuring tissue oxygen tension allow investigators to define the influences of the various deliberate hypotensive techniques more precisely. Such advances may have important implications for clinical practice because significant alterations in organ and suborgan regional blood flow can be obscured when only global indices are measured.

None of the common agents—adenosine triphosphate (ATP), sodium nitroprusside, and nitroglycerin—are associated with a decreased blood flow to any vital organ bed during hypotension to 50 mm of mercury, but sodium nitroprusside and ATP may be associated with decreased splanchnic blood flow. Tissue oxygenation is another matter.

Blood flow and tissue oxygenation have been measured in muscle microcirculation during deliberate hypotension with sodium nitroprusside and nitroglycerin.[1] Sodium nitroprusside was found to dilate the precapillary arterioles but not the venules, resulting in a greater than 50% reduction in the arteriolar-venular pressure gradient for microvascular flow. These results suggest that capillary blood flow may be decreased during nitroprusside-induced hypotension and supports the finding of tissue hypoxia during such hypotension. In contrast, nitroglycerin infusion was associated with dilation of both arterioles and venules and an unchanged tissue oxygen tension (Po_2). Thus, striated capillary blood flow is maintained better during hypotension induced with nitroglycerin than during that using sodium nitroprusside.

Brain oxygenation during hypotension was studied by several investigators. Isoflurane, adenosine, and sodium nitroprusside were all shown to decrease brain oxygen tension during typical deliberate hypotension in sheep or rats and during deep hypotension in pigs. Brain metabolism is least altered with the administration of isoflurane and most altered with that of adenosine. A significant decrease in the sagittal sinus Po_2, accompanied by cerebral acidosis and lactate accumulation, has been reported during adenosine-induced hypotension. One investigator has reported that of the three agents isoflurane, sodium nitroprusside, and 2-chloroadenosine—a stable analog of adenosine—2-chloroadenosine most alters the pattern of brain oxygenation.[2]

These results in animals suggest that deliberate hypotension should be used with caution in humans, for they suggest that the margin of safety for brain oxygenation may be compromised to some degree by these agents. Adenosine use may be associated with the poorest brain oxygenation.

Spinal cord blood flow during hypotension and spinal distraction have also received recent attention. Using trimethaphan camsylate has been shown to decrease spinal cord blood flow to half its normotensive value after hypotension is established. Both nitroglycerin- and nitroprusside-induced hypotension, however, are associated with spinal cord blood flow equal to the normotensive value. Longitudinal spinal distraction does not alter spinal cord blood flow from the hypotensive value for any of of the agents.[3]

Thus, although deliberate hypotension has been used with considerable success in humans, it is not without significant and potentially detrimental effects on regional blood flow and tissue oxygenation under some conditions. It appears that each hypotensive agent has specific peripheral vascular and regional hemodynamic actions and that some agents may be superior in terms of organ blood flow and tissue oxygenation. These data indicate that nitroglycerin may be the drug of choice for inducing hypotension during a nonneurologic surgical procedure. Nitroglycerin, however, is not always effective in decreasing arterial blood pressure to the desired level, and another drug may be used in place of or to supplement its use. Both isoflurane and nitroprusside are appropriate supplements or additions if one keeps the above concepts in mind. Nitroglycerin use may also require significant fluid therapy if preload and cardiac output are to be maintained.

Neurologic operations have the additional requirements of attention to decreased intracranial compliance and the provision of a relaxed brain for surgical access. The use of nitroglycerin has a negative effect on both of these requirements. Isoflurane and nitroprusside are therefore the hypotensive agents of choice during neurosurgical procedures.

In summary, the data for tissue oxygen tension suggest that essentially all of the hypotensive techniques decrease brain tissue oxygenation when hypotension is profound. Thus, deliberate hypotension should be used with caution, with careful patient selection, and with meticulous attention to blood pressure control throughout the period of hypotension. When a clear indication for induced hypotension exists, several relative contraindications should be considered such as coronary artery disease or other cardiac disease in which oxygen delivery would be compromised by hypotension, cerebrovascular and peripheral vascular disease, hypovolemia or anemia, and renal or hepatic dysfunction. The autoregulatory shifts that accompany chronic hypertension must also be considered. Monitoring for induced hypotension should include an arterial line for continuous blood pressure and gas tension monitoring. If a large blood loss or fluid shifts are anticipated, a central line for pressure monitoring and a bladder catheter for urinary output are essential.

(Sperry RJ: Drugs to induce hypotension. West J Med 1988 Sep; 149:362)

From the Department of Anesthesiology, University of Utah School of Medicine, Salt Lake City.

This article was sponsored by the Advisory Panel to the Section on Anesthesiology of the California Medical Association Division of Scientific and Educational Activities.

Reprint requests to Richard J. Sperry, MD, Department of Anesthesiology, University of Utah School of Medicine, 50 N Medical Dr, Salt Lake City, UT 84132.

REFERENCES

1. Endrich B, Franke N, Peter K, et al: Induced hypotension: Action of sodium nitroprusside and nitroglycerin on the microcirculation. Anesthesiology 1987; 66:605-613

2. Seyde WC, Longnecker DE: Cerebral oxygen tension in rats during deliberate hypotension with sodium nitroprusside, 2-chloroadenosine, or deep isoflurane anesthesia. Anesthesiology 1986; 64:480-485

3. Spargo PM, Tait AR, Knight PR, et al: Effect of nitroglycerine-induced hypotension on canine spinal cord blood flow. Br J Anaesth 1987; 59:640-647